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IMAGE RETRIEVAL BASED ON BLOCK COLOR AVERAGING

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ABSTRACT

Although color averaging techniques are widely used in content based image retrieval system because of its computational simplicity and effective retrieval, color averaging technique still suffer in identification of different objects which share the same average color information. To overcome this limitation of color averaging technique, a new technique based on block color averaging is proposed. The proposed technique involves dividing the image to equal sized blocks. The local mean of each block is extracted for feature vector generation. The distance between the features of query image and the features of database images is computed using Euclidean distance. The proposed block color averaging technique is tested on an indexed image database and compared with existing color averaging technique. Experimental results show that the proposed block color averaging technique performs better compared to existing color averaging technique with high precision and recall rate.

Keywords: *Color Averaging, Block Size, Block Color Averaging, Euclidean Distance, Retrieval Efficiency*

1. INTRODUCTION

With the rapid growth of digital technologies and the proliferation of World Wide Web, a huge amount of image databases is being added to the digital libraries frequently. To manage and search this large huge collection effectively and efficiently possessing significant technical challenges raises the necessity of constructing an intelligent image retrieval system.

One of the dominant approaches in the late 1970's is the keyword based image search/ Text based image retrieval [5]. Here, images are accurately annotated manually before being stored in image database. During the retrieval process, the images are retrieved by giving its corresponding keyword as query. This approach is pretty and much simple as it does not require any sort of intricate system to identify the words. Still, text based image retrieval posses few technical limitations and challenges. When the database size is small, it is easy to manually annotate every single image, but to-day with the exponentially increasing image database size, manually annotating every single image in the image database is time consuming, expensive and tedious task. Another problem is due to the lack of coincidence between the information that one extracts from a given data and the interpretation of the same data by a different user in a given situation. Also, there are certain images which cannot be described at all using text, but are tapped using visual features of images.

In addition to the explosive growth of World Wide Web, the quantity of information on the universal repository has started increasing in a spectacular manner; however this information varies considerably in relevance, ranging from precise official information to inaccurate data coming from unknown sources. The great paradox of the web is due to the over abundance of information available for a single subject. As people are surrounded by huge amount of information for a single query, it is getting more difficult for locating the accurate relevant information. Another difficulty comes from the vocabulary mismatch, which means that the information needed is often described by using different words for the same relevant document. The outcome of which is a gap between the human perception of a concept and its machine level interpretations. This gap is called the semantic gap. For example, if the user gives the query term as "apple", the retrieval results could include the

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images of both the apple fruit and apple products. This is because, the query used is text to look for images, without considering the image content. To help reduce this problem efficiently, a need for fully automated search tool is required which could be able to retrieve images based on image content having no compromise given to relevancy, query execution time, cost , human system interface and moreover reduce the load on end user and manual involvement.

Content Based Image Retrieval (CBIR) also known as Query by Image Content [3] is a technique of retrieving images based on image content."Content-Based" means that the search will analyze the actual contents of image rather than metadata such as keywords, tags or descriptions associated with the image. The term "Content" in this context refers to color, texture and shape that can be derived from the image itself. Content Based Image Retrieval involves two steps in the process of image retrieval. Initially a Feature Extraction step, where the feature of query image is extracted separately and the features of all images in database is extracted and stored in a feature database. The second step involves Similarity Matching in which the distance or the similarity between the features of query image and the image features in feature database is calculated using distance measures. Smaller the distance between the images, greater is the similarity.

CBIR is very helpful for the society in analyzing the images based on image content to give better indexing and to increase the retrieval efficiency. CBIR is used in a variety of applications like Architectural and Engineering design, Art collections, Crime prevention, Geographical Information Systems, Remote Sensing, Intellectual property, Medical diagnosis, Military, Photograph archives, Retail catalogues, Agriculture etc.,

2. LITERATURE SURVEY

Shijiao Zhu and Jun Yang [2] used the idea of sub block image. Here, image is divided to 9 parts and each sub block is assigned with different weights. Weights are non-uniformly distributed in such a manner that more weights are given to the central region, less weight to the rim part and the remaining weights to the edges. Similarity of images is calculated based the factors of global similarity and weights of global similarity.

Chan and Chen [7] considered mean value of the color component at each block for calculating the feature vector of an image. The image is divided to 3 x 3 blocks. The mean value is calculated separately for R, G, and B color components of each block. The advantage of considering the mean value for feature extraction is because of the fact, the effects from noises in the images and the variations in sizes of images are significantly reduced. However the disadvantage is that it is easily affected by shift variants of objects in images.

Shih and Chen [9] used partition-based color-spatial technique for extracting the features of an image. Here an image is divided to 100 blocks. For each block, the first three color moments of each color component is extracted and clustered into several classes based on a clustering algorithm. The mean vector of each cluster is regarded as primitive of the image. Though the technique is quite a simple approach; however it is not suitable for certain images containing background occupying a large area of the image since the method only represents the image by mean of the principal color.

Mahdy [6] et al proposed to extract the features from the image using its color histogram. The image is segmented into four blocks and converted from RGB color space to CIE XYZ color space then to LUV color space. The histogram is then calculated from the last color space for each of the four blocks. A histogram similarity measure is used to compare images. Henning Muller [10] et al discussed different appraisal methods for evaluating the performance of image retrieval systems. Various interactive performance evaluations measures including several levels of feedback and user interaction methods are discussed.

Though the existing techniques help in retrieving relevant images, they still pose few limitations. First, the size of color images is large and the computations are quite time consuming. Second, most CBIR systems cannot handle rotation and translation. To overcome the above limitations, the proposed color averaging based image retrieval system is useful for comparing similarities between images with reduced computation time. It also addresses the issue of indexing for the image database.

3. CONTENT BASED IMAGE RETRIEVAL

Content-based image retrieval is a technique of retrieving image which uses the contents of images to represent and access the image. A basic block diagram of content-based image retrieval is illustrated in Figure 1. A typical content-based retrieval system [4] includes two major steps in

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image retrieval: namely feature extraction and similarity matching. In feature extraction step, the system automatically extracts visual attributes (color, shape and texture) of each image in the database based on its pixel values and stores the extracted image features in a different database within the system called a feature database. The feature vector for each of the visual content of each image in image database is much smaller in size compared to the image data; therefore the feature database contains a notion of images in the image database. The next step involves similarity matching and retrieval. The distance between the query image features and the features of images stored in the feature database is computed using Euclidean distance. The similarity between two images represented by their feature values is based on distance measures.

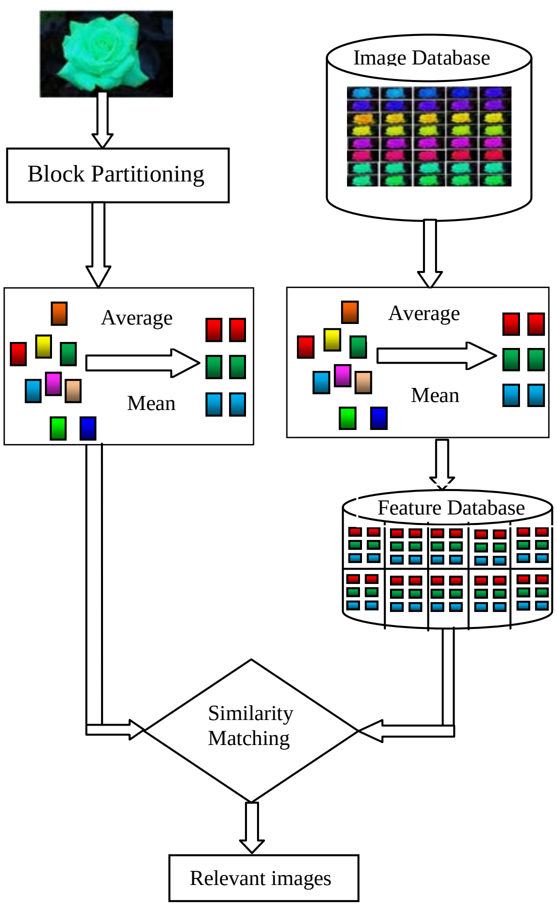

Figure 1: Block diagram of Content Based Image Retrieval

Color is one of the most dominant and distinguishable low level feature, primarily because of its simplicity of extracting color information from images. It leads to minimum error by extracting color features as it is robust to background complication, viewing angle, translation and moreover color is independent of image size and orientation. One of the main advantages of color identification algorithm over shape and texture is because color can be used to identify deformable objects and substances described by mass nouns something which other identification algorithm cannot be used for. Having said this, even though color based algorithm provides an intelligent and automatic retrieval, a better performance can be obtained by using a combination of shape and texture with color.

The main objective of CBIR is to increase the efficiency during image retrieval, thus reducing the need for human intrusion in the indexing process. Selection of image content considered for feature extraction plays a major role in achieving the goal of CBIR.

3.1 Color Averaging

Color Averaging is a technique of averaging the pixel intensities of an image. The pixel intensity values are used for generating the feature vector of an image.

Color averaging based feature extraction is more useful in image retrieval based application for the reason that the human visual system easily differentiates between a large number of colors. Due to its simplicity and the ease of calculation, color averaging is widely used in image retrieval systems. In addition, color averaging based image retrieval techniques are possibly one of the fastest retrieval systems as it is independent of distortions such as translation, rotation and scaling. Though color averaging techniques are extensively used in image retrieval system because of its computational simplicity and due to its insensitiveness to size, orientation and changes in camera viewpoint still color averaging techniques poses a limitation in identifying two different images which share the same mean.

The main drawback of color averaging based technique is that the representation is dependent on the color of the object being studied, ignoring its shape and texture. Color averaging is potentially identical for two images with different object content which happens to share color information. Conversely, without spatial or shape information, similar objects of different color may be indistinguishable based solely on color averaging comparisons.

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Color averaging technique poses difficulty in identifying two dissimilar images with same color and in identifying two similar images with different color that share the same average mean. To solve the problem, many improved methods were proposed in combining the spatial information with the color averaging. Even though the approaches effectively explain the color distribution information, they at the same time lose the color independency which is unsuitable for large scale image database and are also time-consuming. Another existing effective way of obtaining color spatial information is to segment an image into sub-regions and to extract color features from each region [1]. However, it is difficult to segment an image into specific objects effectively and accurately since image segmentation and object recognition is still an existing problem in research area of image processing and pattern recognition.

Figure 2: Dissimilar images with same mean

Figure 2 shows the two images which are entirely different but share the same average pixel intensity for both the images. Color averaging technique assumes the two images shown in Figure 2 as similar images. This is because the average pixel intensity of both the images is same. The reason in the performance degradation of image retrieval system using color averaging technique is because; the image retrieval system considers images with different objects as similar images when they share the same average pixel intensity.

To overcome the limitation of color averaging technique, a block color averaging based technique is proposed which is computationally simpler and faster in query execution.

3.2 Block Color Averaging

In block color averaging, the input image is divided to equal sized non-overlapping blocks. The local mean of each block in database image is compared with its corresponding block of query image for retrieval.

3.2.1Algorithm

1. Read the query RGB image.
2. Divide the input image to six equal sized non overlapping blocks with each block of size, 128 x 128.
3. Compute average row mean for block 1 of a query RGB image using Eq.1

$$\text{Block1}= (\sum_{i=1}^{n} (a[i,j] / n) \qquad (1)$$

4. Repeat step 3 to all six blocks of query RGB image.
5. Each block contains 3 features, one feature to represent each plane of the RGB image.
6. Compute Feature vector of Query image as Feature vector $_{(Query)}$ = [Block1 Block 2 Block3 Block 4 Block 5 Block 6]
7. Repeat step 1 to 6 to all images in image database.
8. Store the extracted image features in a feature database.
9. Calculate Euclidean distance between features of query image and the features of all images in feature database using eq. 2

$$d(x,y) = \text{sqrt}(\sum_{i=1}^{n} (x_i - y_i)^2) \qquad (2)$$

10. Sort images in database in order of ascending euclidean distance to query image and return the result.

The distance between features of query image and the features of all images in database is calculated using Euclidean distance. The distance calculated is sorted in ascending order. An image with less distance is considered as closest match and the images with more distance is considered as least match with the query image.

4. PERFORMANCE EVALUATION

The most common parameters used in evaluating the performance of image retrieval systems are precision and recall [10]. Precision is the number of relevant documents retrieved. Recall is the number of relevant documents in the database which should have been retrieved.

$$Precision = \frac{No.\ of\ relevant\ images\ in\ the\ retrieved\ images}{No.\ of\ the\ retrieved\ images} \qquad (3)$$

$$Recall = \frac{No.\ of\ relevant\ images\ in\ the\ retrieved\ images}{No.\ of\ relevant\ images\ in\ database} \qquad (4)$$

Precision can be understood as a measure of correctness, whereas recall gives a measure of completeness. A perfect precision score of 1.0 state that every retrieved image is relevant but it does not provide any insight as to whether all relevant documents are retrieved. A perfect recall score of 1.0 means that all relevant images is retrieved but

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says nothing about how many irrelevant images might have also been retrieved. Retrieval efficiency states that if the number of images retrieved is lower than or equal to the number of relevant images, then the value is the precision, otherwise it is the recall of a query.

5. EXPERIMENTAL RESULTS AND ANALYSIS

The proposed method is implemented on the following two different databases. General image database and indexed image database.

General image database is formed by picking images manually from standard image databases like FLICKr database, ALIPR database, and Wang database. General image database contains a total of 100 images. The image collection in 100 images is divided into 4 main groups with each main group consisting of 5 sub-groups. Each sub group consisting of 5 images contributing to a total of 25 images in each main group. Images in each group are of a similar type with respect to its background and foreground. The images in database are picked in such a way that two-third of the image size is occupied by the size of the object. Experimental images cover a wealthy of content, including flowers, buildings, natural scenery and animals.

Indexed image database consist of images formed by varying the intensity of a particular color. The indexed image database consist a 5 categories of colors with each category containing 20 images of same color with minor difference in the average mean. The size of indexed image database is 100 and all the images are of size 256 x 384 pixels.

Figure 3:
a)General image database b)Indexed Image Database

Feature vector of a query image and all images in database are extracted. Euclidean distance of all images in database with respect to query image is calculated. The database image with minimum value of Euclidean distance to query image is considered as relevant. The proposed technique based on Block color averaging is implemented using MATLAB R2010a Image Processing toolbox.

The query image is tested on a general image database to check the performance of color averaging technique.

Figure 4: Query Image

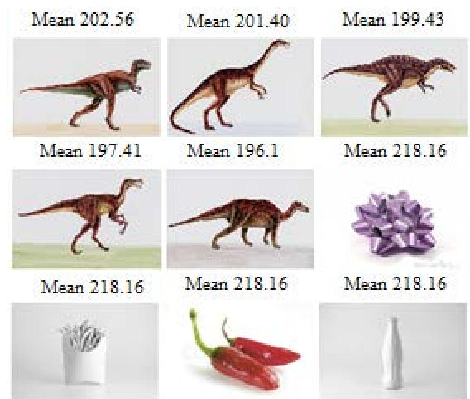

Figure 5: Retrieval results showing images with same mean

Figure 5 shows the retrieval results for the query image shown in Figure 4. It is observed from the retrieval results that the top five retrieved images are relevant to the query image and the remaining four retrieved images are irrelevant to the query image. The reason for this irrelevancy is because the color averaging technique considers all four retrieved irrelevant images as same image. It is noted from the retrieved results that the retrieved irrelevant images, though they share the same average pixel intensity value each irrelevant image poses a different object. As a result the color averaging considers these irrelevant images are relevant to query image and retrieves these irrelevant images in the result. The reason for irrelevancy is due to the cause that the color averaging technique considers pixel intensity values alone for feature extraction without taking into account the spatial arrangement of these pixel intensities in an image. As a result, irrelevant images are retrieved in the output.

To overcome this limitation of color averaging technique and to improve the retrieval efficiency, a block color averaging technique is proposed. To test the block color averaging technique a new indexed image database is formed. The indexed database images are created by varying the hue and keeping the saturation, luminance as constant. The

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images in indexed database almost share the same mean for a particular color and the images differ with minor changes in mean value. This database is created to test images with minor changes in mean value.

The input image is initially divided to equal sized non-overlapping blocks.

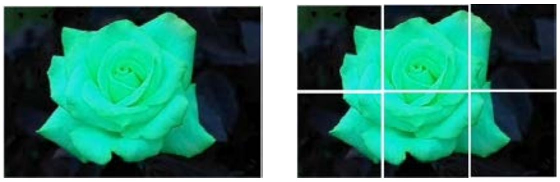


Figure 6: a) Original Image b) Block Partitioned Image

Figure 6a) shows the original image and Figure 6b) shows the block partitioned image. Mean of each block is taken for feature extraction. Local mean of each block is stored in a cell array as the features of an image. The features of all images in the database are extracted and stored in a feature database.

The query image is tested on an indexed image database. The retrieval results are compared with Color averaging based technique.

Table 1: Comparison Of Color Averaging And Block Color Averaging Techniques

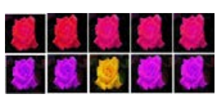
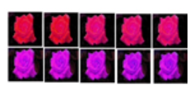
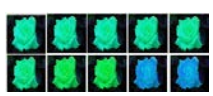
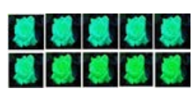
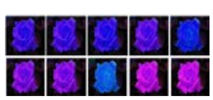
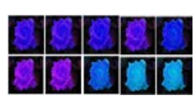
Query Image	Color averaging	Block color averaging
		
		
		

Table 1 shows the comparison of retrieved results between existing color averaging technique and proposed block color averaging technique. It is observed from the retrieved results that for the query image 1, the color averaging technique contains one retrieved irrelevant image. This is because the one retrieved irrelevant yellow color flower image shares the same global mean as the other retrieved images. Where as in Block color averaging the retrieved results shows all retrieved images are relevant to the query image. This is because in block color averaging based technique the local mean of each block is used for comparison. As a result more accurate results are obtained. Similarly for the query image 2 and 3 , the last two images in the retrieved results are irrelevant to the query image.

On the other hand the retrieved images of block color averaging technique imply all 10 retrieved images are relevant to the query image color. The retrieval results states that block color averaging by using local mean gives better retrieval results compared to color averaging with global mean. More accurate results are obtained by using block color averaging compared to the global mean used in color averaging technique.

Table 2: Comparison Of Retrieval Efficiency For Color Averaging And Block Color Averaging Techniques

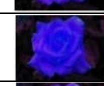
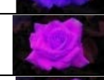
Query Image	Retrieval Efficiency	
	Color averaging	Block color averaging
	80	100
	80	80
	80	100
	80	80
	60	80
	60	80
	70	100
	70	100
	80	100
	90	100
	90	100
	80	100
Average %	76.67%	93.33%

Table 2 shows the retrieval efficiency of Color averaging and block color averaging technique. The retrieval results states that the retrieval efficiency of block color averaging produces better results compared to normal color averaging techniques.

The algorithm is further tested by varying the block size [8] of the image for comparison.

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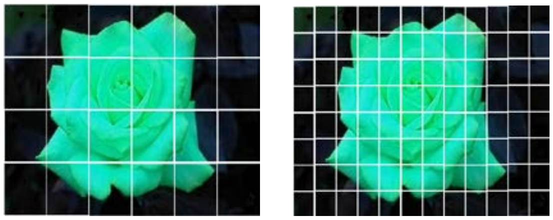

Figure 7: a) 64 x 64 block b) 32 x 32 block

In Figure 7a) the image is divided to 24 non-overlapping equal sized blocks with each block of size 64 x 64. Figure 7b) shows the image divided to 96 non-overlapping equal sized blocks with each block of size 32 x 32.

Table 3: Comparison Of Various Evaluation Parameters For Color Averaging And Block Color Averaging Techniques

Evaluation parameters	Color averaging	Block color averaging	
		64 x 64	128 x 128
Retrieval Efficiency (%)	76.67	95.42	93.33
Time(sec)	11.68	12.08	8.61
Memory(cell)	6400	27520	10240

Table 3 shows the various evaluation parameters used for appraising the performance of existing color averaging and proposed block color averaging technique. The retrieval efficiency of block color averaging with a block size of 128 x 128 gives better results compared to color averaging based techniques.

The proposed block size of 128 x 128 gives better results compared to 64 x 64 with respect to the query execution time and memory. The reason being as the size of the block is reduced to 64 x 64 more accurate results are obtained. However, the computational complexity of retrieving results increases. Also when the image is further divided to smaller blocks of size 32 x 32, the color independency gets reduced, because of which the retrieval efficiency also gets reduced.

In addition as the size of the block is reduced, the memory required for storing the features of each block increases thereby increasing the query execution time.

Table 4: Comparison Of Precision And Recall Values For Color Averaging And Block Color Averaging Techniques

Image ID	Color Averaging		Block Color Averaging	
	Precision	Recall	Precision	Recall
5	0.8	0.36	1	0.55
7	0.8	0.36	1	0.55
21	0.56	0.21	0.73	0.36
22	0.56	0.21	0.73	0.36
23	0.64	0.28	1	0.55
24	0.64	0.28	1	0.55
25	0.73	0.36	1	0.55
29	0.87	0.45	1	0.55
30	0.85	0.45	1	0.55
35	0.8	0.36	1	0.55
Average	72.5%	33.2%	94.6%	51.2%

Table 4 shows the average precision and average recall of color averaging and block color averaging. The results states that block color averaging based technique gives high precision and recall values compared to color averaging technique.

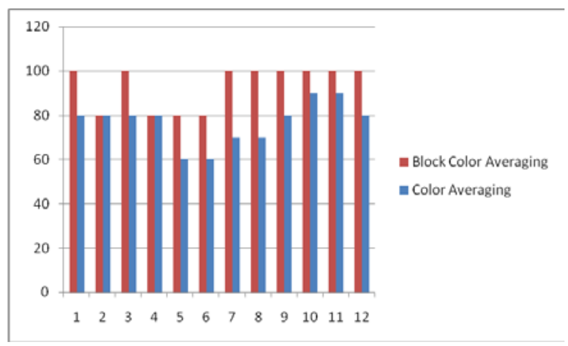

Figure 8: Retrieval Efficiency Graph

Figure 8 states the retrieval efficiency of block color averaging is high compared to the existing color averaging technique. The graph also explains that block color averaging based image retrieval performs better compared to color averaging with respect to time and retrieval efficiency.

6. CONCLUSION

Image retrieval is an active research topic in the field of image processing, pattern recognition, and computer vision. In this paper, a new and efficient block color averaging technique for image retrieval has been proposed which uses the local mean of each block of an image. Experimental results indicate that the proposed method yielded higher average precision and average recall with reduced query execution time and memory than existing color averaging technique. In addition, the proposed

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method also showed high retrieval efficiency over the existing color averaging technique. As further studies, the proposed retrieval method has to be evaluated for robustness on various databases.

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